



## Plasmonic color filters fabricated by soft-X-ray lithography

Wu, Qingjun; Jia, Hao; Xiao, Sanshui ; Zhang, Dongxian

*Publication date:*  
2019

*Document Version*  
Publisher's PDF, also known as Version of record

[Link back to DTU Orbit](#)

*Citation (APA):*

Wu, Q., Jia, H., Xiao, S., & Zhang, D. (2019). *Plasmonic color filters fabricated by soft-X-ray lithography*. Poster session presented at 9th International Conference on Surface Plasmon Photonics, Copenhagen, Denmark.

---

### General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

# Plasmonic color filters fabricated by soft-X-ray lithography

ngjun Wu<sup>1, 2</sup>, Hao Jia<sup>1</sup>, Sanshui Xiao<sup>2</sup>, Dongxian Zhang<sup>1</sup>

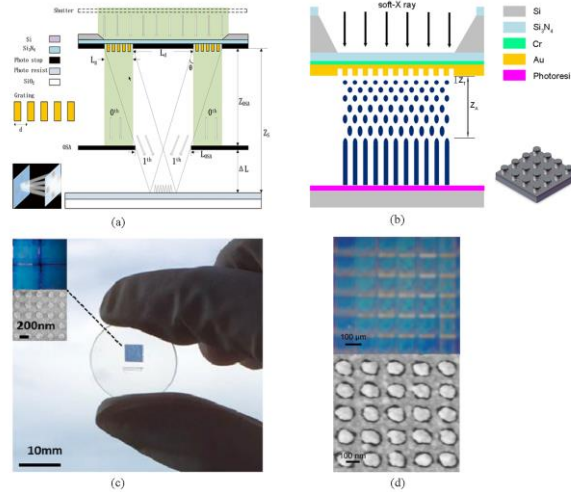
1. State Key Laboratory of Modern Optical Instrumentation, Zhejiang University, Hangzhou, 310027, People's Republic of China
2. Department of Photonics Engineering, Technical University of Denmark, Kgs. Lyngby, 2800, Denmark

**Abstract:** Soft-X-ray lithography has emerged as a newly technique for manufacturing nanopatterns with both high precision and throughput. Here, we utilize four-beam interference lithography and achromatic Talbot lithography to fabricate high-resolution, and large-area color filters.

Conventional top-down lithography techniques with high resolution, such as EBL and FIB, are low-throughput, which restrict large-area fabrication for industrial applications. Recently, soft-X-ray lithography with high resolution, strong exposure intensity and excellent coherence has generated considerable interest as a promising technique for manufacturing nanopatterns with both high precision and throughput. Here we utilize four-beam interference lithography [1] and achromatic Talbot lithography (ATL) [2], by utilizing soft-X-ray interference lithography to achieve stitching nano-patterns and fast fabrication of large-area color filters. The samples are mainly prepared at the Soft-X-Ray Interference Lithography Beamline (BL08U1B) in Shanghai Synchrotron Radiation Facility (SSRF).

Four gold gratings were used as the mask of four-beam interference lithography. Nanodot arrays were realized via the first order interference of four-beam Soft-X-Ray. In order to obstruct the zeroth order, an order sorting aperture (OSA) was placed closely but disconnectedly in front of wafer. The large-area manufacturing of nanocylinder arrays was achieved by stitching multiple exposure fields. Fig. 1 (a) shows the scheme of four-beam interference lithography. Fig. 1 (c) shows the color filter sample with the period of 230 nm fabricated by four-beam interference lithography whose area is 4 x 4 mm<sup>2</sup> and its optical micrograph and SEM image.

Achromatic Talbot lithography method makes use of Talbot effect, which is a well-known phenomenon in which illuminated objects with periodic transmission profile produce self-images at certain distances. Compared with four-beam interference lithography, a single grating mask is employed in ATL, which simplifies the mask fabrication process, and enables to use full of illuminating area. Fig. 1 (b) shows the schematic illustration of achromatic Talbot lithography. The color filter consists of the silicon substrate, HSQ cylinder and Ag film. Fig. 1 (d) shows the optical micrograph and SEM image of the color filter with the period of 200 nm fabricated by ATL whose area is 0.72 x 0.72 mm<sup>2</sup>.



**Fig. 1** (a)The scheme of four-beam interference lithography. (b)The scheme of achromatic Talbot lithography. (c) the optical micrograph and SEM image of the color filter with the period of 230 nm fabricated by four-beam interference lithography. (d) the optical micrograph and SEM image of the color filter with the period of 200 nm fabricated by ATL.

## Acknowledgement

Financial support from National Key Research and Development Program of China (No. 2017YFA0403403), China Scholarship Council (Nos. 201706320249) and the Open Foundation of the State Key Laboratory of Modern Optical Instrumentation (No. MOIKF201701).

## References

- [1] Sun, L., Hu, X., Wu, Q., Wang, L., Zhao, J., & Yang, S., et al., "High throughput fabrication of large-area plasmonic color filters by soft-x-ray interference lithography". *Optics Express*, 24(17), 19112 (2016).

[2] Wu, Q., Xia, H., Jia, H., Wang, H., & Jiang, C., et al., "Fast and large-area fabrication of plasmonic reflection color filters by achromatic Talbot lithography". *Optics Letters*, in press (2019).